MonA01

Towards 20 A Negative Hydrogen Ion Beams for Up to 1 hour: Achievements of the ELISE Test Facility

Ursel Fantz, Bernd Heinemann, Dirk Wünderlich, Rudi Riedl, Werner Kraus, Ricccardo Nocentini, Federica Bonomo and the NNBI Team
Max-Planck-Institut für Plasmaphysik, Garching, Germany

Corresponding Author: Ursel Fantz, e-mail address: ursel.fantz@ipp.mpg.de

The RF ion source test facility ELISE (Extraction from a Large Ion Source Experiment) is part of the R&D roadmap of the European ITER domestic agency F4E for the ITER neutral beam injection systems. ELISE is dedicated to demonstrate the ITER requirements in terms of accelerated negative hydrogen densities (230 A/m^2 H^-, 200 A/m^2 D^-) at an electron-to-ion ratio of less than one for a source of the same width but only half the height of the ITER source (0.9 x 1 m^2). According to an extraction area of 0.1 m^2, consisting out of 640 beamlets with a diameter of 14 cm each, and including the calculated stripping loss for negative ions in the extraction system of 30% a current of 33 A for H^- and 28.5 A for D^- has to be extracted at a source pressure of 0.3 Pa. Another challenging requirement concerns the beam duration und beam homogeneity: beams up to 3600 s have to be achieved and deviations in the uniformity of the large beam of less than 10% are allowed only. The negative ions are created via the surface conversion process, i.e. the conversion of mainly atoms and positive ions at surfaces with a low work function, for which caesium is evaporated into the source.

The ELISE test facility went into operation in November 2012 with a first maintenance phase after two years of operation. For hydrogen a stable 1 hour plasma discharge with repetitive 10 s beam pulses was demonstrated with 9.3 A extracted current and an electron-to-ion ratio of 0.4 using a 20 kW RF power for each of the four drivers only, which is less than a quarter of the available RF power. At 45 kW RF power per driver and thus half of the available RF power a stable 400 s plasma discharge with extracted beam pulses of 18.3 A (same duty cycle) at an electron-to-ion ratio of 0.7 could be achieved. Challenges in the long pulse operation are the caesium dynamic in the source and the stability of the co-extracted electron current, the latter being the limiting parameter for the power load on the extraction grids and thus for the source performance. The paper focusses on the presentation of the results achieved and the challenges with special focus on long pulse operation. Furthermore, the latest results from the new campaign in which, for the first time, deuterium will be used for source conditioning of a Cs-cleaned source will be reported.